

Original article

The Rationalization of Port Logistics Activities: A Study at Port of Santos (Brazil)

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Abstract

This paper presents a study of the port logistics activities at the port of Santos (Brazil). The study follows a qualitative approach and it is based on in-depth interviews with some key actors from Santos port logistics chain. Based on these interviews, the main dysfunctions and improvement opportunities associated to the container port logistics processes at Santos were identified. The results show that the main dysfunctions are related to the existing information flows. Due to this, a new information flow related to the studied port is proposed and some probable results of the implementation are identified. The findings contribute both to the studied port and to the academic community, as the number of studies addressing port logistics activities is still limited.

Keywords: Port Logistics Activities; Information Flows; Analysis; Port of Santos (Brazil)

I. Introduction

The recent development of port studies suggests a growing interest in this field (Pallis, Vitsounis and De Langen, 2010; Pallis et al., 2011; Woo et al., 2012). The scale of research related to ports increased substantially during the 2000s and became a dominant theme in the area of maritime economic studies. A diversification of port research is perceived with several new themes emerging, reflecting the evolution of the port industry and the changing role of ports in supply chains and logistics (Woo et al., 2012).

Most of these studies address efficiency issues; however, few present an analysis of logistics flows. To fill this gap, the present study aims to analyse the port logistics activities at the Port of Santos, the most important in Brazil and the largest in Latin America regarding container throughput, in order to identify the main dysfunctions and improvement opportunities associated to the port logistics processes of containerised cargo.

The study justifies itself by a better understanding of port community and specifically by the identification of the main dysfunctions and improvement opportunities existing in the port logistic processes of containerised cargo at Santos. The proposed direction to rationalise port processes can reverberate in competitiveness increase of sectors that use the port, what reinforces the importance of this study. The work is timely once recent data reveals traffic jam problems, inefficiency and high costs in container operations at Port of Santos. Besides that, the opportunity to explore synergies with a viability study of single window implementation in Brazilian ports (Llop et al., 2011), developed by *Fundación Valenciaport* (Spain) for Brazilian Ministry of Ports (*Secretaria de Portos - SEP*) made the study viable. Furthermore, an analysis of recent literature on this subject shows that the number of studies addressing the port logistics activities is still limited. It is important to highlight that this study differs from previous researches because it provides a broader approach to port logistics chain and it presents a deeper analysis of the key information flows existing in this chain.

II. Materials and Methods

The study followed a qualitative-exploratory approach and was organised into four steps: i) literature review; ii) data collection through in-depth interviews; iii) analysis and interpretation of the interviews; and iv) improvement actions proposition. Regarding literature review, it was organised into three subjects. The subject 'Logistics and International Physical Distribution' subject aimed to understand the logistic flows where port logistic activities are found. In the 'Port Logistics Chain' the main actors were identified and logistic flows among them were described. And finally, previous studies focusing on the port logistics activities were present.

The data were collected through individual interviews. The port community actors that were considered to be interviewed were: i) Santos Port Authority - named as PA; ii) a container terminal - named as CT; iii) a ship agent acting in Santos - named as SA; iv) a customs broker bound to São Paulo State Customs Broker Union (*Sindicato dos Despachantes Aduaneiros de São Paulo – SINDASP*) - named as CB; and v) an employee from Customs Office (*Delegacia da Receita Federal*) in Santos - named as CO.

The interviews were conducted in the context of a viability study of single window implementation in Brazilian ports (Llop et al., 2011), developed by *Fundación Valenciaport* (Spain) for Brazilian Ministry of Ports (SEP) with resources from Spain's Government Viability Studies Fund – *Fondo de Estudios de Viabilidad* (FEV). The term single window, according to recommendation No. 33 of the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT, 2005), refers to a mechanism that allows the involved parts in international trading and transport to present the necessary documents and information to fulfil the regulations related to import, export and transit operations in a standard way, in a single entry point and only one time.

The data were recorded on digital media to facilitate its subsequent description, analysis and interpretation. Each description was sent to critical appreciation of each individual interviewee aiming to eliminate dubious points and complement any possible gaps, which has served as validation of interview's description. The interviews presented variable duration, situated between 2.5 and 3 hours.

After the interviews, content analysis was carried out and the main dysfunctions and improvement opportunities were identified and classified. Factors were initially classified into two groups considering their location and origin. Regarding to location, two kinds of factors were identified: i) the ones related to vessels operation (berthing, loading and unloading); and ii) the ones associated to the cargo (procedures to the entrance and release of containers, full and empty). On the other hand, regarding to origin, factors were classified in: i) factors associated to physical flow – entrance and release of containers and vessels operation; and ii) factors related to information flow – documents, systems, etc. Due to the high number of identified factors, in order to have a better classification, they were grouped into four categories, according to the aspects they are related to: i) coordination/governance; ii) regulation; iii) information systems; and iv) operations.

III. Literature Review

Supply chain and logistics are usually characterised by three kinds of flows (Beamon, 1998): i) physical flows from suppliers to customers; ii) financial flows, which occurs discontinuously and

in reverse direction of the previous one, from customers to suppliers; and iii) information flows, that allow to coordinate both previous flows, as well as the supply chain as a whole. Physical distribution occurs among different chain links, always from suppliers to customers, along with corresponding financial and information flows. When suppliers and customers are located in different countries, International Physical Distribution (IPD) activities will be executed and part of these activities or flows are directly related with the ports, both departing and arrival, and are considered port logistics flows.

The different activities associated to port logistics flows can be grouped into three categories: i) activities associated to vessel berthing; ii) activities related to vessels loading and unloading, including transferring cargo from the quay to container yard (and vice versa); and iii) activities at the container yard, like cargo receiving, handling and delivering. All these activities take place in ports of loading and discharge, are associated to physical, financial and informational flows and are performed by the different actors of port logistics chain such as exporters, importers, ocean carriers, ship agents, international freight forwarders, non-vessel owner common carriers, customs brokers, container terminals and port authorities. It is also important to highlight the public bodies which act as consenters in export and import operations and have impact over information and documents flows at the ports. In the Brazilian case, the main ones are: Customs (*Receita Federal*), National Agency for Sanitary Vigilance (*Agência Nacional de Vigilância Sanitária - ANVISA*), Ministry of Agriculture, Livestock and Supply (*Ministério da Agricultura, Pecuária e Abastecimento - MAPA*) and Federal Police (*Polícia Federal*). There are also other actors that act in port operations and have significant influence in physical flows such as stevedores, pilots, tugboats, etc.

Brazilian port system is composed by 34 public ports that are under SEP's control. From these ports, 16 are delegated, granted or have the operation authorised to community or municipal governments. The other ports are administrated directly by the 'Docas Companies', joint stock companies which have as major shareholder the Federal Government and are directly bound to SEP. The container and other terminals are operated mainly by private sector since Brazilian Port Law promulgation in 1993. This logic tends to deepen with the new Brazilian Port Law of 2013, which aims to increase private participation in the sector.

The recognition of the major logistics flows in exports and in imports and the relationship between the main actors of the port logistics chain is crucial for the analysis and subsequent rationalization of port logistics activities. In addition, it is also important to analyse previous studies on the subject, in order to identify the main contributions and the remaining gaps in the literature.

To identify previous researches with the same approach of this study, i.e., focused on the analysis of port logistics activities, a search in the Science Direct database was conducted. The terms 'port' and 'logistics process' were searched in titles, abstracts and keywords of articles from

2012 to present. The search process was conducted in March 2015. A total of 21 articles were found, but two articles focused on airport logistics process were excluded. The remaining 19 articles were then analysed in order to check its adherence to the subject studied.

It was observed that, from the 19 analysed articles, 6 have been partially adherent to the studied subject and only 2 have been considered completely adherent. Since many studies focusing on port activities and port logistics processes are developed by consultants to governments, ports and terminals, the circulation of these reports is usually restricted to the professional field, and their results are not published in international journals. After this pre-selection, these 8 articles that are more related to the studied subject were analysed. The synthesis of the results is presented in Table 1.

Table 1: Analysis of literature adherence to the subject studied

Authors	Subject studied	Adherence
Bae (2012)	Analysis of relationships between environmental uncertainty, logistics information systems, logistics integration (internal and external) and customer service performance of port logistics firms	Partial
Coronado Mondragon et al. (2012)	Event flow mapping and network modelling analysis to determine the feasibility of ITS to support real-time data traffic related to port logistics chain	Yes
Hall, O'Brien and Woudsma (2013)	Role of stakeholders collaboration in port environmental innovation process	Partial
Ascencio et al. (2014)	Collaborative Supply Chain Management System for a Maritime Port Logistics Chain	Partial
Lee and Wu (2014)	Simultaneous measurement of economic and environmental performance using a multi-methodological approach	Partial
Sutrisnowati, Bae and Song (2014)	Analysis of the lateness probability of container process using a Bayesian network	Partial
Wang et al. (2014)	Development of a comprehensive methodology for applying process mining in port logistics process	Yes
Verhetsel et al. (2015)	Stated preference study related to location of logistics companies	No
Wilmsmeier, Monios and Rodrigue (2015)	Analysis of the spatial distribution of seaports and inland ports considering the case of port of Veracruz (Mexico)	Partial

Source: Authors, based on literature review

Bae (2012) conducted an analysis of relationships between environmental uncertainty, logistics information systems, logistics integration (both internal and external) and customer service performance of port logistics firms. This reference is useful for the present study due to the identification of the main types of logistics firms and its roles. In addition, the study provides a brief discussion about logistics information systems (LIS) as a requirement to promote logistics

integration (LI) and logistics performance. It's important to highlight that the integration of the different port logistics actors, the existing information flows among these actors and the LIS that support these information flows are important issues to improve the port logistics chain. These issues are also addressed in the present study.

In turn, Coronado Mondragon et al. (2012) made an event flow mapping and network modelling analysis to determine the feasibility of ITS to support real-time data traffic related to the exchange of messages, which are representative of the flow of events taking place in multimodal logistics and which can be associated to high-impact capabilities with economic repercussions such as track and trace. This study presents a process mapping and modelling/simulation and follows a qualitative approach based on case study with a site visit. In general terms, this methodology is similar to the one used in the present study.

More recently, Hall, O'Brien and Woudsma (2013) studied the role of stakeholders' collaboration in port environmental innovation process. This is an interesting reference due to the identification of key actors and innovation process in the port logistics chain.

A more recent study was conducted by Lee and Wu (2014) in which the authors seek to address the way that economic and environmental performance can be measured simultaneously. The study includes a process mapping and takes a multi-methodological approach to the logistics and supply chain management field in order to address sustainability challenges. This kind of approach combines multiple research procedures to explore the problem studied. Among these procedures are the 'as-is process mapping' and the 'to-be process mapping' in the earlier steps. These procedures are similar to the process analysis applied in the present study. The results obtained by Lee and Wu (2014) indicate that it is better to simultaneously consider performance indicators from different perspectives and to integrate them into one model of system measurement in order to improve sustainability performance.

In that same year, Ascencio et al. (2014) proposed a collaborative logistics framework for a maritime port logistics chain. Since the proposed collaborative logistics framework is based on the integration of the business processes of the port logistics chain with its stakeholders, this reference also shows some convergence with the present study. Also in 2014, it was found a study analysing the lateness probability of container process using a Bayesian network and considering various factors in container handling (Sutrisnowati, Bae and Song, 2014). This reference is adherent to the case study because it presents a comprehensive mapping and a consistent analysis of port logistics process.

Wang et al. (2014) developed a comprehensive methodology for applying mining process in port logistics activities. This is a useful reference since it presents a consistent methodology to the analysis of port logistics process, with an application to a Chinese bulk port.

From the references found on Science Direct database with the considered searching terms in the 2012-March 2015 period, the latest is the Wilmsmeier, Monios and Rodrigue's (2015) study.

This study presents an analysis of the spatial distribution of seaports and inland ports, considering the port of Veracruz (Mexico). Issues as customs clearance, rail regulation, cargo security and land acquisition are considered, and the conflict among models of development depending on the priorities of inland and port actors are discussed. Some of these items are also addressed in the present study on port logistics processes at the port of Santos.

IV. Results and Discussion

From the interviews 16 factors that represent dysfunctions or improvement opportunities in port logistics processes at Santos were identified. These factors can be classified by its location (wharf or yard) and associated logistic flow (physical or informational) according to Table 2. Some factors (F1, F5, F7, F13 and F14) were marked with ‘xx’ in information flow, which means that dysfunctions were found both on the wharf and in the yard.

Regarding ordering by importance, it was observed that two factors were cited by three among five interviewees: the ‘Multiplicity of systems to manage the operations’ (F1), mentioned by SA, CT and PA; and the ‘Complexity in the documental procedures with high paper storage’ (F7), mentioned by CT, CO and CB. The ‘Impossibility of Customs be aware of the cargo loading until the information is entered into *Siscomex Carga* by the agent’ (F2) and ‘High dwell times in importing’ (F3) were named by two interviewees.

Table 2: Number of factors, location and associated logistic flow

Factor	Interviewee / n°	Location		Associated Flow		
		Wharf	Yard	Phys.	Inform.	
F1- Multiplicity of systems to manage the operations	Ship Agent Container Terminal Port Authority	3	x	x		xx
F2- Impossibility of Customs be aware of the boarding until the information is entered into <i>Siscomex Carga</i> by the agent	Customs Office Ship Agent	2	x			x
F3- High imports dwell times	Ship Agent Container Terminal	2		x	x	
F4- Difficulty in entering export cargo into the terminals as a reflex of import dwell times	Ship Agent	1		x	x	
F5- Need to create a communication channel between Customs and the terminals	Ship Agent	1	x	x		xx
F6- Need to make available the customs clearance information by Customs to ship agents	Ship Agent	1		x		x
F7- Complexity in the documental procedures with high paper storage	Container Terminal Customs Office Customs Broker	3	x	x		xx

F8- Need of download at Siscomex Carga and inquiry at Siscomex Importação to the terminal release the containers	Container Terminal	1		x		x
F9- Impossibility to Customs visualise into a system the location of dangerous goods into the terminal	Container Terminal	1		x		x
F10- Lack of a system to integrate the different public agents responsible to the physical check of the containers	Container Terminal	1		x		x
F11- Lack of criteria to define which containers should be physically checked	Container Terminal	1		x	x	
F12- Need of governance to create port single window	Port Authority	1	x			x
F13- Need of adjustments in current legislation	Customs Office	1	x	x		xx
F14- Tax secrecy as restriction to send information from Siscomex to other systems	Customs Office	1	x	x		xx
F15- Difficulties to adjust Siscomex on a national basis due to communities tax particularities	Customs Office	1		x		x
F16- Lack of other consenters besides Customs Office at Siscomex Exportação	Customs Office	1		x		x
Sum			7	14	3	18
x: Factors with dysfunctions located at the wharf or the yard; xx: Factors with dysfunctions located at the wharf and the yard						

Source: Data Analysis

With regards to consensus level between the interviewees, it is possible to perceive that despite the significant dispersion observed among the factors both CT and SA mentioned three of the four most cited factors, while CO mentioned only two. This is reinforced by the analysis of all the 16 dysfunctions and improvement opportunities since seven were named by CT, six by SA and five by CO. Even Though there are dysfunctions and improvement opportunities in flows associated to vessels (wharf) as well as in the ones related to cargo (yard), it was observed that the main dysfunctions and improvement opportunities are concentrated in the procedures done at the terminal yards and information flows. Besides that, no factor related to physical flow on the wharf was identified.

The factors (F1 to F16) identified by the interviewees can be grouped in four categories, as follows: i) problems associated to governance (port logistics chain management); ii) problems related to regulation issues; iii) problems related to information systems; and iv) problems related to operations. It is noticed a concentration in 'information systems' category, followed by 'regulation' and 'operations'. Although governance has been directly associated to only one factor (F12), it can be considered as a necessary condition to improve port operations as a whole, considering physical flows and activities located in both the wharf and the yard.

From the analysis of the interviews it is possible to graphically represent the current information flows (Figure 1). The situation found shows three important points, which are: i) the need of the development of an effective single window to vessels call, implementing and expanding the Porto Sem Papel (PSP), the Brazilian single window, since currently the procedures are executed in duplicity and using multiple information systems (*Mercante*, *Siscomex Carga*, *Supervia* and also PSP); ii) the need to expand the port single window (PSP) to port logistics processes, including the private actors in order to create a system that allows the rationalization of the processes and the elimination of paper; and iii) the need to rationalise the inefficient processes at the terminals, reducing current dwell times.

From the situation found it is possible to propose a reorganization of information flows at Port of Santos, rationalizing port logistic processes according to what is presented in Figure 2. Initially it is necessary to implement PSP and make the single window effective to procedures associated to the vessels (call data and cargo manifests), eliminating multiple data entries. It is also necessary to eliminate the need for exporters and importers to present documents when the information has already been entered into the government information systems. Such information could be concentrated and distributed to the other systems from PSP. Besides that, it is necessary to expand the PSP to the processes related to cargo and include in this system the private actors forming a Port Community System (PCS). In such way, *Siscomex* could automatically inform cargo status to PSP/PCS allowing the automatic container release without papers and inquiries.

The PSP would be chosen as integrating element due to the fact that the ports (in this case Santos) are important links in international logistic chain and present relations with the main actors in it. The other systems (*Siscomex*, *Mercante*, *Supervia* and *DT-e*) have more specific purposes (specially associated to operations control and tax collections) that would difficult its operation as integrating element and the necessary coordination (governance) of the actors in order to make the system work properly.

González-Cancelas (2007) presents in his thesis two references of containers dwell times: i) the International Association of Ports and Harbours (IAPH) criterion which considers an average dwell time of 6 days; and ii) the criterion considered by Rotterdam Port – from 4 to 6 days. Martner-Peyrelongue and Moreno-Martínez (2011) mention dwell times in four Mexican ports (Veracruz, Manzanillo, Lázaro-Cárdenas and Altamira) from 4.5 to 6.4 days in 2009 to full containers and from 4 to 7.5 to total of containers. Another reference that can be cited is a report from an interministerial study made in India to reduce containers average dwell time in the main terminals of the country (Government of India, 2007). The results reveal dwell times in 2005/2006 of 1.88 day in import and 3.78 days in export. In a comparison of international ports, it was mentioned 3 to 4 days in Rotterdam and only 0.85 in Singapore for the same period and operations. However, it is important to highlight that in Singapore the operations are mainly transshipment.

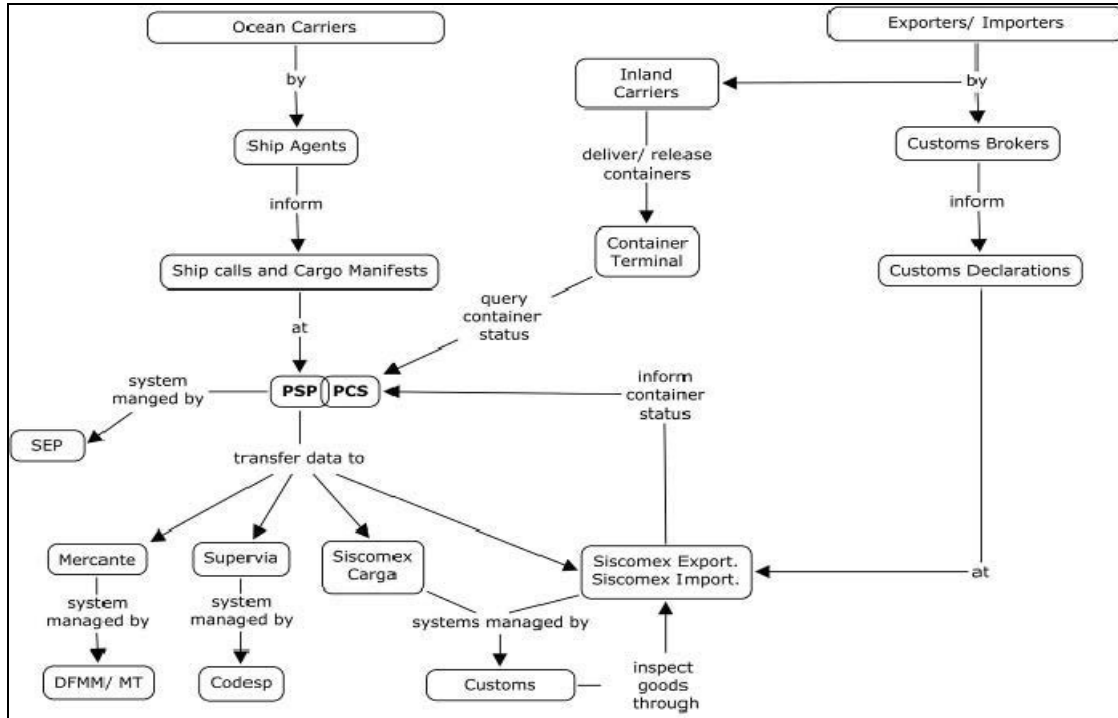


Figure 1: Current information flows at Port of Santos

Source: Authors

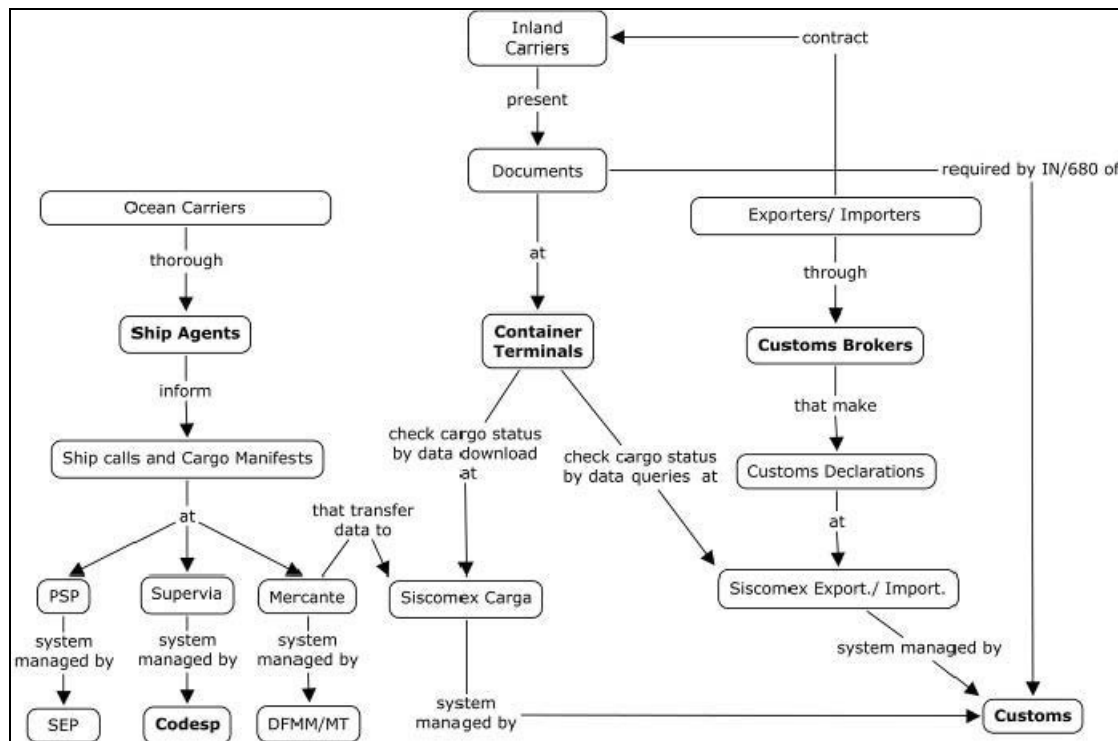


Figure 2: Proposed information flows at Santos

Source: Authors

In the case of Brazil, according to Port of Santos data, dwell times in 2012 at the main container terminal at Santos – were 5.6 days in export and 15.6 days in import. Dwell times at the second largest container operator in Santos in the same year were similar. Most of the containers dwell time in Santos is due to customs procedures, especially in import, and the main dysfunctions are associated to information flows. Therefore, with the implementation of the proposal information flows presented in Figure 2, dwell times at Port of Santos could significantly be reduced, approaching the international standards without the need for infrastructure investments.

V. Conclusions

Ports, which are key links in logistics chain, need to be efficient and effective in order to respond adequately to their customers' demands. To do so, it is necessary to rationalise port logistics processes and the associated physical, financial and information flows. This need becomes even more important due to the lack of investment in capacity expansion at Brazilian ports and the export boom that has occurred over the past few years (Wanke, Barbastefano and Hijjar, 2011).

The present study revealed itself as an opportunity to rationalise information flows at Port of Santos, the major port in Brazil and Latin America. The main problem found was the high dwell times due to inefficient information flows both in import and export. To outline this problem, the following was proposed: i) a new information flow in which the main changes refer to implementation of a port single window (PSP); ii) its integration with the existing international trade single window (*Siscomex*) and with other existing systems; and iii) the extension of it to cargo processes and private actors with the development of a PCS.

From the proposed improvements it will be possible to simplify the existing bureaucratic procedures and maximise the use of port infrastructure, decrease costs and improve service level to customers, mainly by reducing the dwell time of import and export. It is estimated that the potential time reduction can approach the studied port to performance standards verified internationally. It is also important to highlight that this kind of solution can generate results in a shorter timeframe and with less investment than traditional solutions based in port infrastructure expansion which reinforce the relevance of the study.

5.1. Limitations of the research

One must also consider the limitations on the used approach - qualitative. Qualitative research does not numerically measure the studied phenomena; does not intend to generalise results obtained; does not claim the studies to be replicated and is not based on statistical analysis. This

type of research seek to understand the phenomenon studied in their usual environment and capture experiences in the languages of the individuals themselves, basing on an inductive process (from the particular to the general).

Another thing to point out as limitation concerns the number of in-depth interviews conducted (only five port logistics chain actors). However, the interviewed actors can be considered key to understanding this chain and provided sufficient information for the realization of the study and the achievement of its objectives.

Finally, another limitation of this study, and very usual in qualitative research, refers to the difficulty of classifying and isolating factors, since respondents may name differently the same factors. However, this limitation does not affect the analysis of port logistics process as a whole.

5.2. Managerial implications and future research directions

The study findings reveal many managerial implications. First, it is evident the lack of coordination between the actors and logistics flows in the studied port, especially with regards to information flows and associated information systems. This is a key aspect to be considered by the various actors involved in this chain (government, port authority, container terminals, ship owners, freight forwarders, exporters and importers).

The main consequence of this problem is the increase in dwell times and port costs for ships and containers. This issue goes beyond infrastructure investments: is associated with the efficient use of the available infrastructure.

As future studies, we suggest the development of similar research in other Brazilian ports, the comparison among different studies and benchmarking with more efficient ports. Another important gap to be filled in the literature concerns the identification of appropriate performance indicators to measure the efficiency (or inefficiency) of information flows in the port logistics chain.

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